3D Computer Vision
https://cv.inf.elte.hu/

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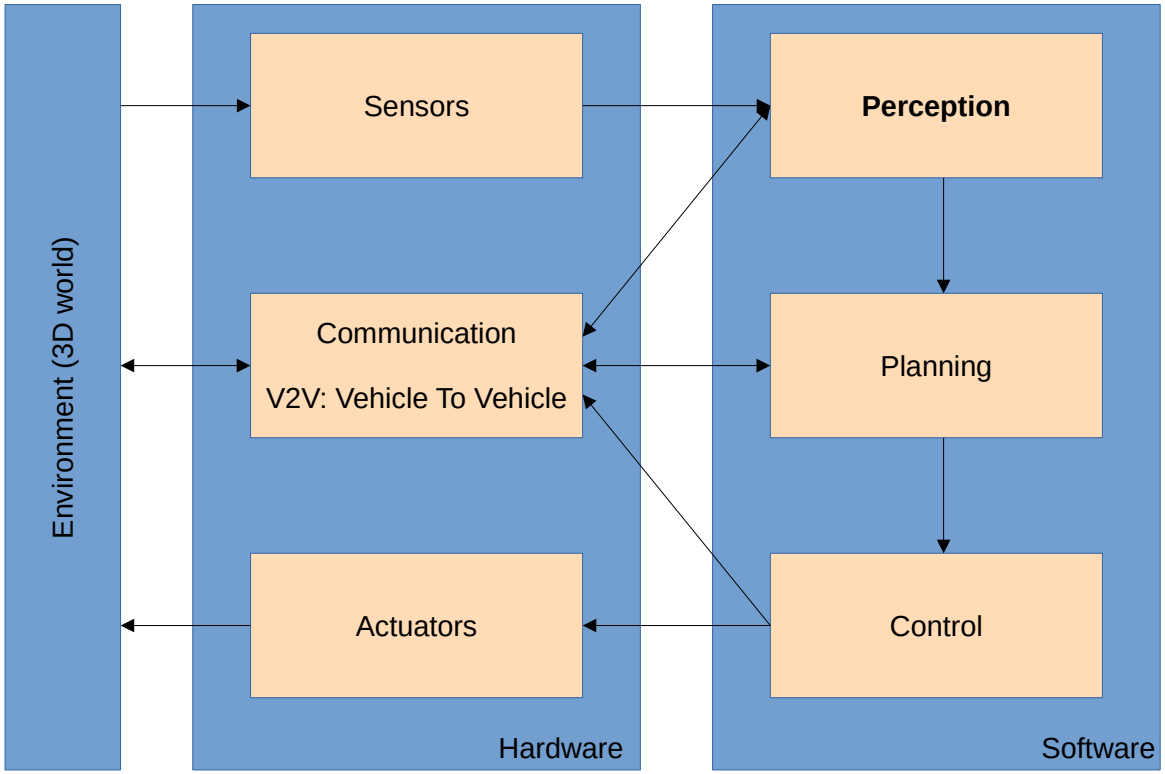
Motivation 1/2

- 3D vision is a very important domain within computer engineering/science
  - Tasks are usually very challenging
  - Results are very spectacular
  - Needs both high theoretical and practical skills
- Several sensors can be connected to computers, we apply here
  - digital camera images and
  - point clouds recorded by 3D Lidars

Motivation 2/2

System Overview of an Autonomous Vehicle



Subject Overview

- Goal: overview of (i) (basic) 3D vision and (ii) point cloud processing methods
- We also need knowledge in estimation theory.

- Introduction to algebric problems
  - Least-squares fitting (inhomogeneous/homogeneous problems)
  - Robust fitting $\rightarrow$ Outlier filtering
- Point Cloud Processing
  - Plane fitting
  - Sphere fitting
  - Cylinder fitting
- Introduction to Computer Vision
  - Camera models, Projections, Single-view vision, stereo vision, multi-view vision

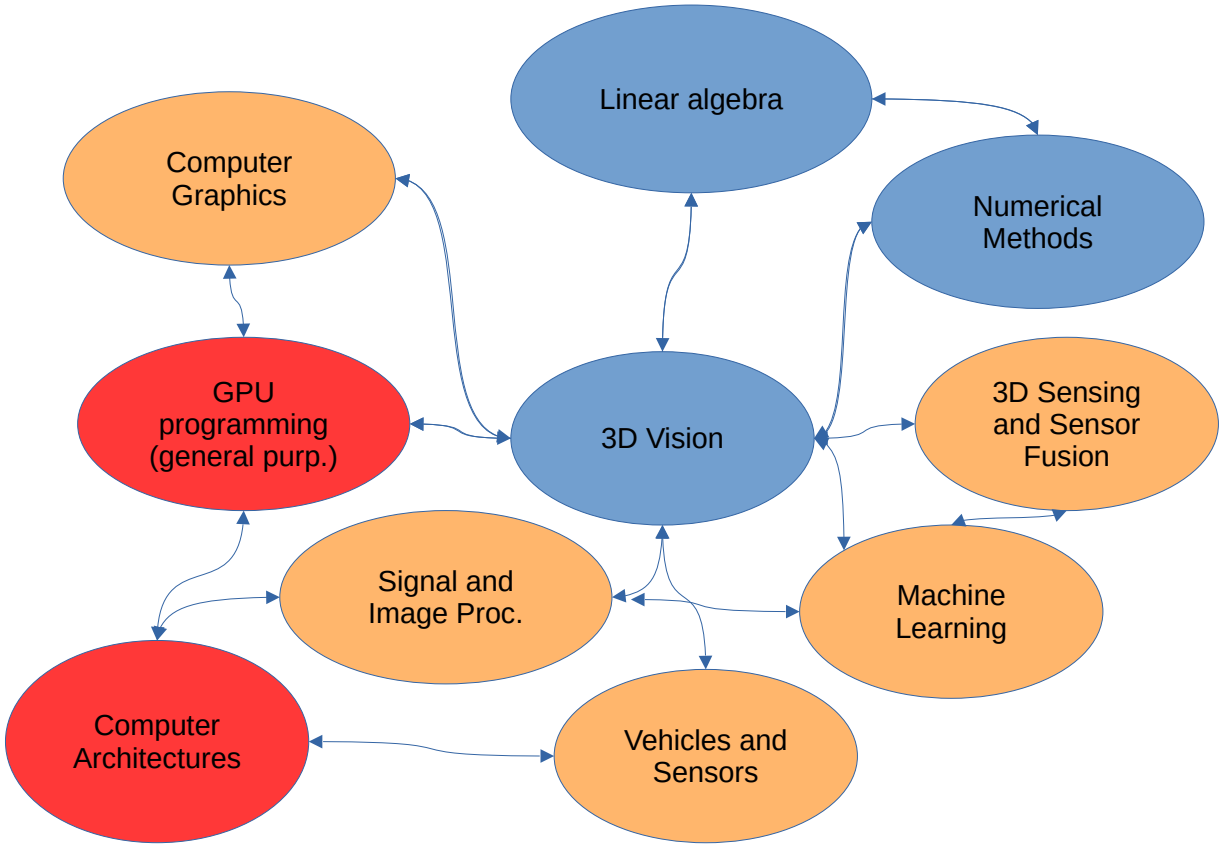
3D Vision Content – Lecture

- Introduction to estimation theory
  - Homogeneous/inhomogeneous linear systems
- Robust estimation (RANSAC method)
- Transformations, projections
- Homography: definition, estimation, applications
- Camera calibration
- Stereo vision
  - Theoretical background
  - Fundamental/essential matrices, their estimations
  - Planar motion (vehicle-mounted cameras)
- Multi-view reconstruction
  - Bundle Adjustment
  - Tomasi-Kanade factorization
- Special hardwares for 3D vision

3D Vision Content – Practice

- Demonstration of sensors
- Affine transformations
- Pinhole camera model
- Robust fitting, multi-model fitting
- Homography estimation: panoramic images
- Camera Calibration
  - using 3D object
  - or chessboard pattern
- Stereo Vision: 3D Reconstuction
- fundamental Mtx estimation, essential decomposition, triangulation
- 3D Reconstruction by weak perspective camera model
  - Tomasi-Kanade factorization

Related Subjects



3DVision Teachers

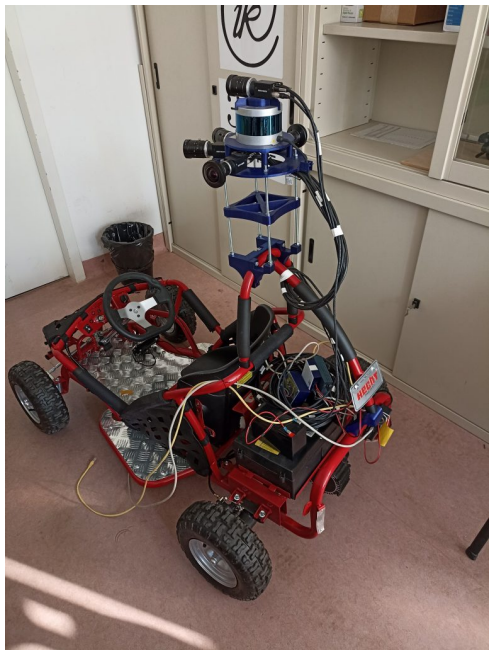
- Levente Hajder
- Tamás Tófalvi
- Tarlan Ahadli

Our forums

- Canvas `https://canvas.elte.hu`
  - Materials
  - Assignments
- Webpage `https://cv.inf.elte.hu`
  - Under construction
  - `https://cv.inf.elte.hu/index.php/education/3d-computer-vision/`
- Teams
  - It will be created next week.

3D Vision Requirements

- Lecture
  - Oral exam in examination period
  - Topics will be published before exam-period
- Practice
  - Two or three assignment in termtime
- Combined mark is given: 50-50% from oral exam and assignment
  - 20-20% should be received for both oral exam and assignments
  - Max 50% for assignment / oral parts
- Final grade
  - 5 (excellent): $\geq 85\%$
  - 4 (good): 70 . . . 84 %
  - 3 (satisfactory): 55 . . . 69 %
  - 2 (pass): 40 . . . 54 %
  - 1 (fail): $< 40\%$

First (Irregular) Practice

- Demonstration of our vehicles and sensor-kit
- We gather at the 'Danube entrance' of South Building
  - Friday, 12th September, 10:30